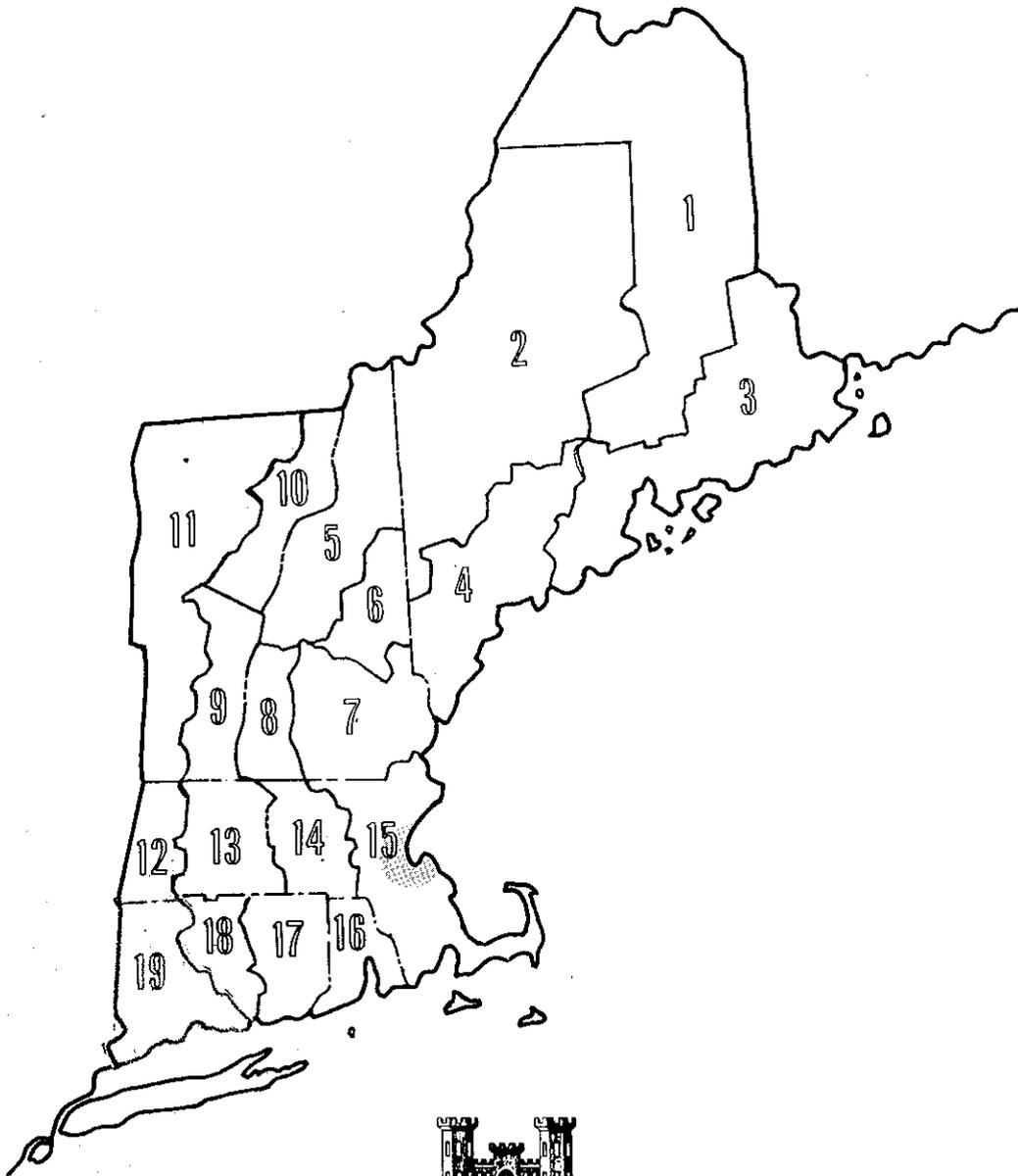


NORTHEASTERN UNITED STATES WATER SUPPLY STUDY
METROPOLITAN BOSTON AREA
(Part of OBE Sub-Region 15)
INCLUDING PRESENT AND FUTURE
SUBURBAN MDC WATER CUSTOMERS

INTERIM MEMORANDUM NO. 6



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

SEPTEMBER 1968

NORTHEASTERN UNITED STATES
WATER SUPPLY STUDY

INTERIM MEMO NO. 6

METROPOLITAN BOSTON AREA
(Part of OBE Sub-Region 15)

Including Present and Future Suburban
MDC Water Customers

August 1968

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

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METROPOLITAN BOSTON AREA
(Part of OBE Sub-Region 15)
Interim Memo No. 6

1. PURPOSE OF REPORT

This interim memo is being submitted in accordance with scope of work detailed in Memorandum dated 21 November 1967, as part of this Division's participation in the Northeast Water Supply Study for the New England Area. It suggests that the water supply situation in the metropolitan Boston area is likely to change by the 1980's, and suggests further that additional municipalities will be connected into the current MDC water supply system. Such a new demand would exceed the present safe yield. An increase in the present supply system could be accomplished by diversions into Quabbin Reservoir, and these potential diversions are discussed later in the report. Interim Memo #6 should be reviewed together and in conjunction with Interim Memos #5 and #7.

2. SCOPE OF STUDIES

a. General Information. Preliminary studies and investigations of reconnaissance scope have been made to determine water supply requirements for the Metropolitan Boston area, representing a portion of sub-region 15, which includes Boston and surrounding cities and towns within a radius of approximately 20 miles. Conferences with the Construction Division and the Water Division of the Metropolitan District Commission (MDC); the Metropolitan Area Planning Council (MAPC); the New England Regional Commission (NERC); the City of Boston Water Department; and the U. S. G. S. have been held. In addition, a review has been made of the existing reports and publications of the Massachusetts Senate, U. S. Department of Health, Education and Welfare, the agencies named above, and their consultants.

The findings of this series of interim reports are oriented toward an action program to meet the water supply needs of the metropolitan area beyond 1980 if it were substantially expanded in scope as described in paragraph #5 herein. In addition to the growing demands of the core city and the cities and towns already serviced by the MDC, there is the increasing inability of the surrounding municipalities which now have independent supply systems to meet their growing demands. If the projected demands of these

municipalities are added to those of the present MDC customers, the total projected demand will exceed the present safe yield of the MDC system by 1981.

b. Topographic Surveys. Topographic information was obtained from U. S. Geological Survey Maps, from the reports of consultants to above-mentioned agencies, and from Corps of Engineers' sources such as the Charles River Watershed Study group.

c. Geologic and Subsurface Information. Subsurface information was obtained from U. S. Geological Survey publications, conversations with U. S. G. S. representatives in Boston, and a report by the Weston Geophysical Engineers, Inc., Weston, Mass., entitled "Compilation of Geophysical Studies throughout Massachusetts."

d. Office Studies. Office studies consisted of projecting present water demands and supplies, and determining the projected deficiencies for the core city and the various municipalities in the metropolitan area.

e. Field Reconnaissance. Field reconnaissances of possible reservoir sites were not made because preliminary investigations by the Corps for parts of other going studies have provided an adequate record for use in this reconnaissance report. Future reports of greater scope would, however, require more detailed field investigations.

3. PRIOR REPORTS

No prior reports have been transmitted by NED on the specific subject of the Northeast Water Supply Study for this area. The NENYIAC study of 1954 contains information that is generally applicable to "NEWS" in such areas as topography and geology, surface and groundwater availability, pollution and recreation. In addition are documents published by the Massachusetts Senate, No. 760 and No. 808, which concern the water supply system in the metropolitan Boston area, and include a discussion of possible diversions to provide same.

4. DESCRIPTION OF AREA

Metropolitan Boston is the cultural, industrial and commercial heart of New England, and Boston itself is a major financial center for both the region and the country. This area is highly urbanized. The resulting

intensive land use and population density have resulted in the use of almost all the metropolitan watersheds as commercial, residential or industrial land use. Since ground water sources are grossly inadequate for the large demand, the source of water supply comes from the Connecticut River Basin, about 70 miles west of Boston.

Surface water is the main source of supply for the present MDC customers, except for a few existing wells, some of which are kept on standby, while many of the prospective customers described in paragraph 5 use ground water, either solely or in conjunction with surface water. Quabbin Reservoir impounds the runoff from 186 square miles of the Swift River watershed and from 98 square miles of the Ware River watershed. Its surface area of 38.6 square miles affords a capacity of 412 billion gallons. Water is brought from the reservoir through a series of conveyances to the metropolitan area. The history and a description of the present water supply system are also discussed in Interim Memorandum No. 5, Paragraph 5, entitled "Metropolitan District Commission Water Supply System."

5. PRESENT WATER SUPPLY SITUATION

This report is concerned with those municipalities currently not part of the MDC System but located within the metropolitan, 15-mile radius, Boston area. It suggests that the MDC will be called upon to provide water to these cities and towns which, under the existing statutes, have the right to be admitted but have not yet exercised this option.

It is the stated objective of the MDC to be able to provide water to all of the municipalities that request service, including those outside of the 15-mile limit. This is possible under the portion of the law that provides for such service if (a) the municipality requests service, and (b) the MDC commissioners approve the request. (Under existing law, all cities and towns within a 15-mile radius of the State House in Boston, must be serviced by the MDC upon request). At the present time, the MDC is not encouraging such requests due to insufficient reserve supply at Quabbin. However, when the planned program of diversions into Quabbin gets under way, the supply will be sufficient to permit additional connections. (This expansion program is discussed in Interim Memo No. 7, as well as herein).

The cities and towns not now connected to the MDC but which could, under the law, demand service and are expected to do so, as reported by the MDC, are:

10-mile radius

Braintree
Canton
Dedham
Hull
Wellesley
Weymouth
Woburn

15-mile radius

Estimated Early Group (1970-1975)

Cohasset
Hingham
Holbrook
Lynnfield (entire town)
Natick
Randolph
Reading
Westwood

Estimated Late Group (1975-1985)

Bedford
Billerica
Burlington
Concord
Dover
Walpole
Wayland
Wilmington

Others (that could request, but not demand, service)

Estimated Early Group (1970-1975)

Hudson
Scituate

Estimated Late Group (1975-1985)

Acton
Maynard
Stow
Sudbury

These municipalities are currently self-sufficient, but some are nearing the safe yield of their systems and are planning to connect to the MDC in the near future. Some of them, mostly those listed in the "Late Groups" above, have a safe yield adequate for the next decade, but anticipate a high growth rate that will result in additional supply sources being needed by the middle 1970's. Connection to the MDC at that time could solve their supply problems.

6. PROJECTED FUTURE WATER REQUIREMENTS

The projections given in Tables I, II & III are for the cities and towns not now on the MDC system. These municipalities in the aggregate could impose an additional demand by 2020 of 170 MGD.

TABLE I

	1965(Actual)		1975	1990	2000	2000	2020	2020	REMARKS	
	ESTIMATED									
	Pop.	GPCD	MGD	MGD	MGD	GPCD	MGD	GPCD		MGD
<u>10-Mile Radius</u>										
Braintree	33,954	99	3.4	5.1	7.4	145	7.0	168	8.4	
Canton	15,310	116	1.8	2.6	5.4	167	6.2	191	8.6	
Dedham	26,618	81	2.2	2.5	4.0	123	3.9	145	4.9	
Hull	23,000(avg)	82	1.3	1.9	3.3	125	3.7	148	4.9	
Wellesley	26,297	118	3.1	3.9	6.6	168	5.4	192	6.7	
Weymouth	50,468	70	3.6	4.5	6.9	115	6.2	135	8.3	
Woburn	35,149	120	4.2	6.2	8.7	170	8.5	194	10.7	
SUB-TOTALS	210,796	-	19.6	26.7	42.3	--	40.9	--	52.5	
<u>15-Mile Radius</u>										
(Early Group: 1970-1975)										
Cohasset	6,559	61	0.5	0.6	1.2	98	1.5	118	2.4	
Hingham	17,576	82	1.3	1.9	3.7	125	4.8	148	6.5	
Holbrook	11,231	62	0.7	1.0	1.3	99	2.0	119	3.0	
Lynnfield (entire system)	9,821	67	* 0.4	* 0.6	* 1.0	107	1.8	128	2.4	*These figures are for the present Lynnfield Fire District only
Natick	30,365	185	5.6	6.0	11.1	223	8.5	223	9.4	
Randolph	21,726	62	1.3	2.1	3.9	99	4.5	119	6.0	
Reading	21,188	96	2.0	2.9	4.3	143	5.4	166	7.3	
Westwood	12,123	82	1.0	1.5	3.2	125	3.0	148	4.2	
SUB-TOTALS	130,589	-	12.8	16.6	29.7	--	31.5	--	41.2	

TABLE II

	1965(Actual)		1975	1990	2000	2000	2020	2020	REMARKS	
	Pop.	GPCD	MGD	MGD	MGD	GPCD	MGD	GPCD		MGD
<u>15-Mile Radius</u>										
<u>(Late Group:</u>										
<u>1975-1985)</u>										
Bedford	10,787	101	1.1	2.1	2.9	148	3.6	171	5.0	**Billerica is also at present listed as a member of the Greater Lowell Area Planning Commission
Billerica**	23,633	77	1.7	2.6	5.7	118	6.5	139	8.4	
Burlington	19,473	98	1.9	2.8	3.9	146	3.9	168	5.0	
Concord	14,516	113	1.5	2.0	3.8	153	4.1	176	5.8	
Dover	3,592	(Pop. served = 375)			0.1	82	1.0	103	1.8	
Walpole	16,390	114	1.8	2.5	5.3	154	5.7	178	8.2	
Wayland	12,192	92	1.1	1.6	3.2	138	3.9	160	5.6	
Wilmington	15,261	174	2.6	4.4	7.6	236	7.1	236	8.5	
SUB-TOTALS	115,844	--	11.7	18.0	32.5	--	35.8	--	48.3	
<u>OTHERS(Outside</u>										
<u>the 15-mile radius)</u>										
<u>Early Group:</u>										
<u>(1970-1975)</u>										
Hudson	13,642	83	1.0	1.4	3.1	126	3.1	149	4.5	
Scituate	14,458	91	1.6	2.3	4.6	138	3.6	160	5.0	
SUB-TOTALS	28,100	--	2.6	3.7	7.7	--	6.7	--	9.5	

TABLE III

	1965 (Actual)		1975	1990	ESTIMATED		2020	2020	<u>REMARKS</u>
	<u>Pop.</u>	<u>GPCD</u>	<u>MGD</u>	<u>MGD</u>	<u>GPCD</u>	<u>MGD</u>	<u>GPCD</u>	<u>MGD</u>	
OTHERS(Outside the 15-mile radius) Late Group: (1975-1985)									
Acton	10,188	82	0.8	1.6	3.9	125	5.3	148	7.4
Maynard	9,070	84	0.8	1.1	1.9	126	1.9	149	3.0
Stow						--	--	--	--
Sudbury	10,894	88.5	0.8	1.4	2.7	135	5.5	157	7.5
									No public supply
SUB-TOTALS	30,152	--	2.3	4.1	8.5	--	12.7	--	17.9
<u>TOTAL</u>	<u>515,481</u>	--	<u>49.0</u>	<u>69.1</u>	<u>120.7</u>	--	<u>127.6</u>	--	<u>169.4</u>

The projections for population, GPCD and MGD for 1965, 1975, and 1990 are taken from the Eastern Massachusetts Regional Planning Project Report dated May 1967. These figures originally were produced by the Metropolitan Area Planning Council in early 1967 after a detailed study. The projections for values beyond 1990 are by NED and are based on our best estimate.

Adding these projected demand figures to the needs of current MDC customers now served results in the following:

	Actual MGD	Projected MGD			
	<u>1965</u>	<u>1975</u>	<u>1990</u>	<u>2000</u>	<u>2020</u>
Present MDC Customers	250.4	299.2	416.4	500	600
Potential MDC Customers	<u>49.0</u>	<u>69.1</u>	<u>120.7</u>	<u>130</u>	<u>170</u>
Totals	<u>299.4</u>	<u>368.3</u>	<u>537.1</u>	<u>630</u>	<u>770</u>

7. POSSIBLE SOURCES OF WATER FOR FUTURE DEVELOPMENT

Assuming that the present sources of the municipalities which will join the MDC are kept in service, the present safe yield of 102 MGD of these systems then would be added to the existing 330 MGD safe yield of the present MDC system, providing a new total safe yield of 432 MGD for this new MDC system. Since the total potential demand on the new system could reach 432 MGD by 1981, additional sources of supply would have to be available at that time.

Barring any technical breakthrough in saline conversion, the possible sources of water to meet the needs projected in this report, because of the relatively large quantities involved, appear to be two:

1. Diversions into Quabbin Reservoir from various tributaries of the Connecticut River.
2. Diversion from the Merrimack River, into either Quabbin or a new regional reservoir.

Smaller rivers, such as the Ipswich River, even now intensively developed for water supply, will at most be able to meet purely local needs, and have not been considered as a regional source.

Diversions into Quabbin include the Northfield project (72 MGD), reported in Memo #5, and the Millers River diversion (189 MGD).⁽¹⁾ The present safe yield of 330 MGD⁽²⁾ would be increased to 504 and 693 MGD respectively by the implementation of these two projects, and the inclusion of the existing supply systems of the potential customers. However, much of the Millers River system is polluted and cannot be used as a source for water supply in the near future. One exception is the Tully River, one of its tributaries. There is an existing Corps' flood control dam on the Tully River in the town of Royalston, and preliminary talks between the Corps and the MDC have been held to determine the feasibility of enlarging the existing facility to include water supply. Increases in storage capacity for water supply of between 54,000 and 85,000 acre-ft. (approximately 48 MGD and 76 MGD) have been mentioned as a possibility, but no further investigation beyond this very preliminary estimate has been made. Work has already begun on the power portion of the Northfield Mountain project, but work on the water supply portion is still held up pending final agreement of various legal details.

Other possible diversions into Quabbin could be from the Deerfield River (on the west side of the Connecticut River). The Deerfield River has a total drainage area of 664 s.m. At a proposed reservoir site in Charlemont, Mass., it has a drainage area of 362 s.m. and a 53-year average safe yield of 565 MGD.⁽³⁾ The elevation of the proposed Charlemont reservoir is higher than that of Quabbin, so that gravity flow from this proposed impoundment to Quabbin is possible. Diversions from the Merrimack River could be directed to Quabbin or other reservoirs on the present MDC system, but it would be desirable to consider reducing the conveyance cost by locating the purification facility and a new reservoir to the north of Boston. Because of the topography and population density, no sites for a reservoir the size of Quabbin are available in this area, but a few potential sites appear to be available south of the Merrimack River in Andover and Wenham. Further study will be necessary to determine if a new reservoir is feasible or if any future diversion from the Merrimack should be into one of the existing MDC reservoirs. The Merrimack River has a total drainage area of 5,010 square miles, and would provide a safe yield of about 3,000 MGD, depending upon the location of the diversion. Ground water supplies are totally inadequate for a demand as large as is projected, and so only surface supplies are considered as potential sources.

(1) Mass. Senate Document #760, May 1962, page 19.

(2) Ibid, page 17.

(3) U. S. G. S., "Water Resources Data for Mass., N. H., R. I., VT." 1966, page 173.

8. RECOMMENDED ALTERNATIVES FOR FURTHER INVESTIGATION

The Northfield Mountain diversion currently is being considered, and would increase the new 432 MGD safe yield of the MDC system to 504 MGD. This will satisfy the total potential demand of both the present and potential customers of the MDC (see paragraph 6) until 1987. Another source such as the Tully Dam improvement would have to be completed and ready to supply water after that period. This additional potential yield of between 48 MGD and 76 MGD (to be determined by a future study) will provide a new total system safe yield of between 552 MGD and 580 MGD, which would satisfy the total potential demand of both the present and potential customers until between 1992 and 1995. Diversion from the Deerfield River into Quabbin could provide a supply adequate for both the present and potential customers as defined in paragraph 5 until the year 2020.

The preceding considers only diversions into Quabbin, which are expected to be adequate until 2020, and not the possible advantages which might result from withdrawals from the Merrimack River. Using the Merrimack as a source would provide a supply adequate beyond any projected future needs. It also could result in a relatively short conveyance system. It would have the disadvantage of the cost of a new reservoir and sizeable purification facilities.

Advantages of the successive diversions into Quabbin are that these new conveyances into an existing reservoir from both the Northfield Mountain and Tully Dam projects are small and are parts of multiple-purpose developments. The Deerfield diversion also could be a multiple-use operation.

Disadvantages of the Deerfield diversion are the increasing length of conveyance (about 100 miles from Charlemont to Boston) that would be required, and the decreased storage time in Quabbin with a resulting possible adverse effect on quality. In addition to new conveyances from proposed new diversions into Quabbin, added conveyances between Quabbin and Boston would have to be installed in order to transmit increased supplies.

Assuming that the present supply systems of the new MDC customers continue in use after these customers are added to the MDC system, and the Northfield Mountain diversion is completed, the potential demand of the expanded system would be met at least until 1987. A recommended course of action for the NEWS program is as follows:

1. Prepare a survey report for the Tully Dam (Millers River) project. This would provide the next 5-8 year increment of water supply (from 1988 until between 1992 and 1995).

APPENDIX I

Size of Conveyances

in the

Metropolitan Boston Area

APPENDIX I

<u>MUNICIPALITY</u>	CONVEYANCE SIZE (inches)								
	24	30	36	40	48	54	56	60	63
Arlington	X		X				X	X	
Bedford									
Belmont							X		
Boston	X	X	X		X				
Brookline		X	X		X	X			
Burlington									
Cambridge	X	X		X	X			X	X
Canton									
Chelsea			X	42"					
Cohasset									
Concord									
Danvers		X	X						
Dedham			X						
Dover									

APPENDIX I

MUNICIPALITY	CONVEYANCE SIZE								
	(inches)								
	24	30	36	40	48	54	56	60	63
Everett	X	X	X	42"	X				
Framingham	X								
Hingham									
Holbrook									
Hull									
Lexington	X		X						
Lincoln									
Lynn	X	X	X						
Lynnfield W. D.			X						
Malden	X	X	X		X				
Medfield									
Medford	X	X			X			X	
Melrose			X						
Middleton	X								

APPENDIX I

CONVEYANCE SIZE

(inches)

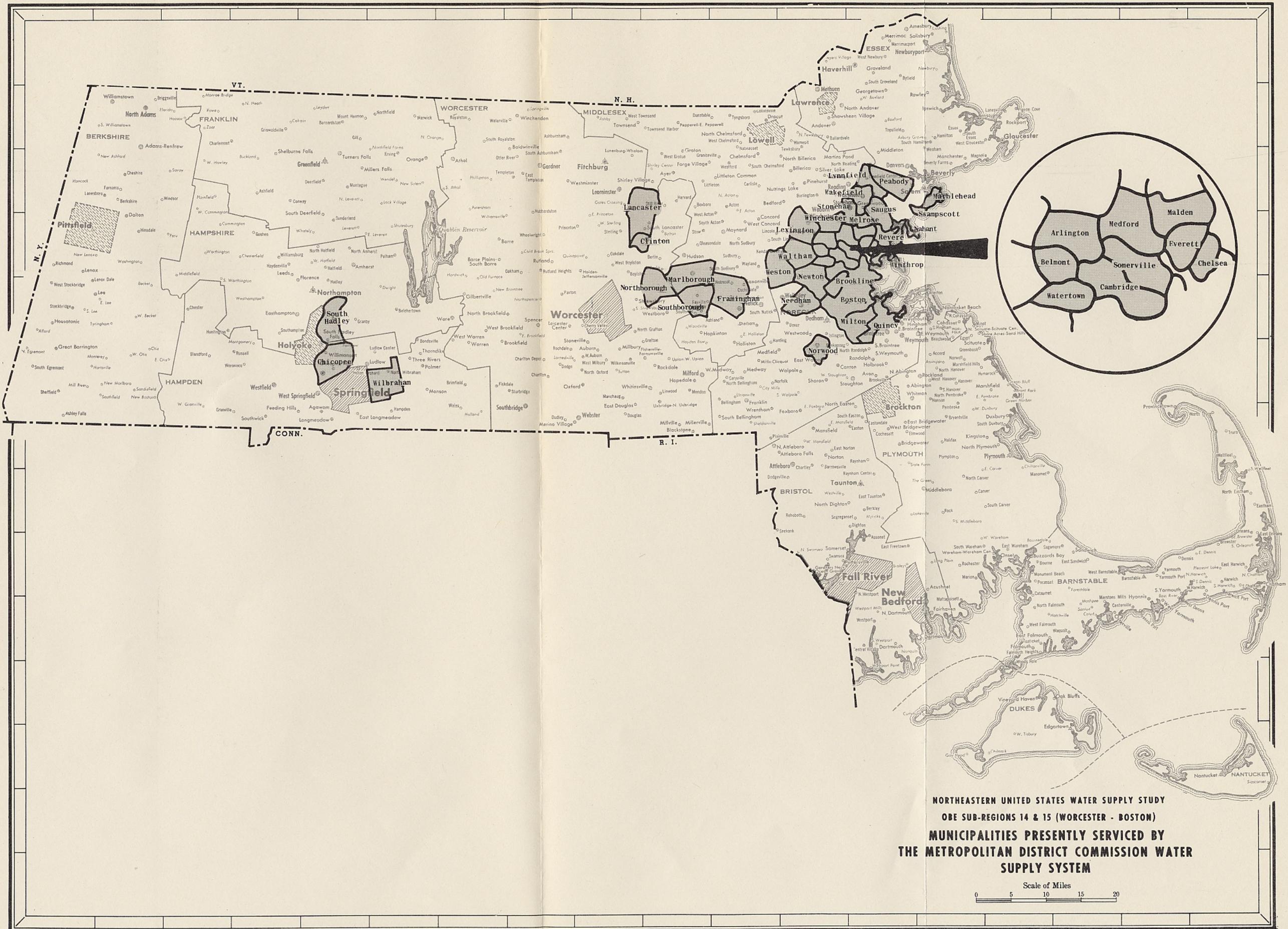
<u>MUNICIPALITY</u>	<u>24</u>	<u>30</u>	<u>36</u>	<u>40</u>	<u>48</u>	<u>54</u>	<u>56</u>	<u>60</u>	<u>63</u>
Millis									
Milton	X								
Nahant									
Natick									
Needham									
Newton			X		X			X	
Norfolk									
No. Reading									
Norwood	X		X						
Peabody	X	X			X				
Quincy					X				
Randolph									
Reading	X	X							
Revere	X	X	X						

APPENDIX I

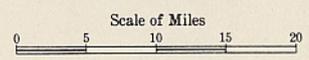
MUNICIPALITY	CONVEYANCE SIZE (inches)								
	24	30	36	40	48	54	56	60	63
Salem			X						
Saugus		X	X						
Sharon									
Sherborn									
Somerville	X	X	X		X				
Southborough									
Stoneham	X		X	38"	X			X	
Stoughton									
Sudbury									
Swampscott									
Wakefield									
Walpole									
Waltham	X	X	X				X	X	X

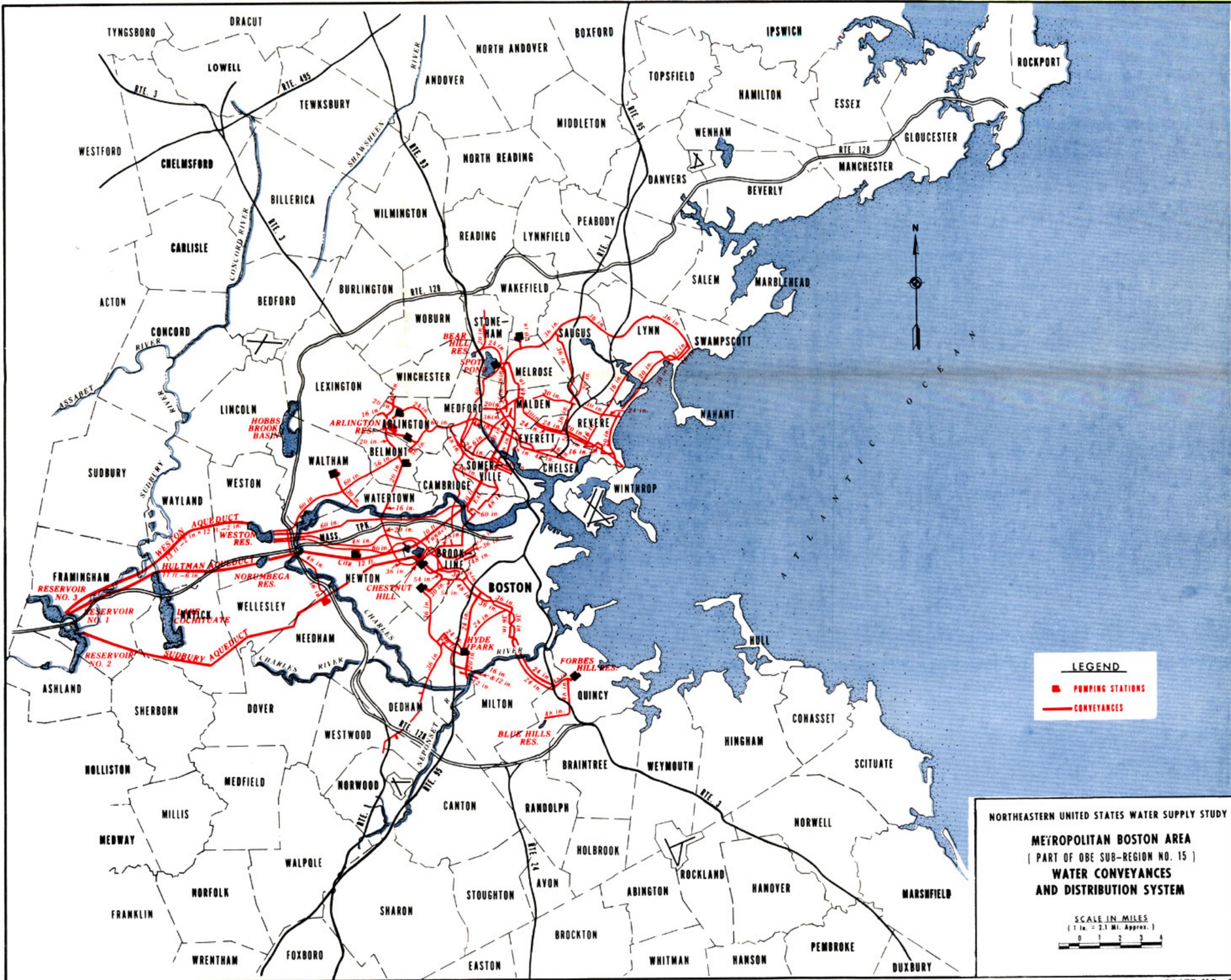
APPENDIX I

<u>MUNICIPALITY</u>	CONVEYANCE SIZE								
	(inches)								
	24	30	36	40	48	54	56	60	63
Wayland									
Wellesley			X						
Weston									
Westwood									
Weymouth									
Wilmington									
Winchester				X					
Winthrop									
Woburn					X				



NORTHEASTERN UNITED STATES WATER SUPPLY STUDY
ODE SUB-REGIONS 14 & 15 (WORCESTER - BOSTON)
MUNICIPALITIES PRESENTLY SERVICED BY
THE METROPOLITAN DISTRICT COMMISSION WATER
SUPPLY SYSTEM





LEGEND

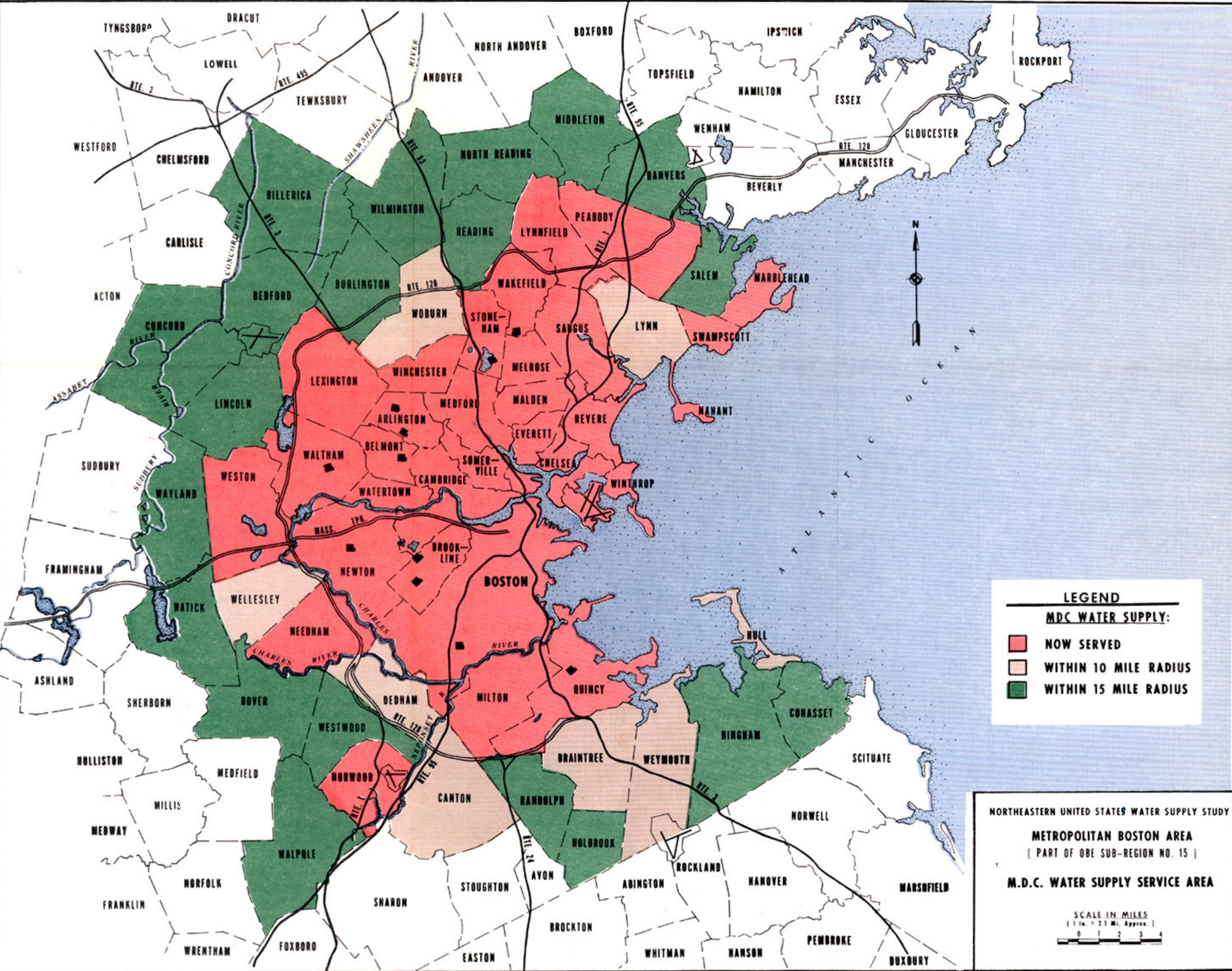
- PUMPING STATIONS
- CONVEYANCES

NORTHEASTERN UNITED STATES WATER SUPPLY STUDY

METROPOLITAN BOSTON AREA
(PART OF OBE SUB-REGION NO. 15)

WATER CONVEYANCES AND DISTRIBUTION SYSTEM

SCALE IN MILES
(1 in. = 2.1 Mi. Approx.)



LEGEND

MDC WATER SUPPLY:

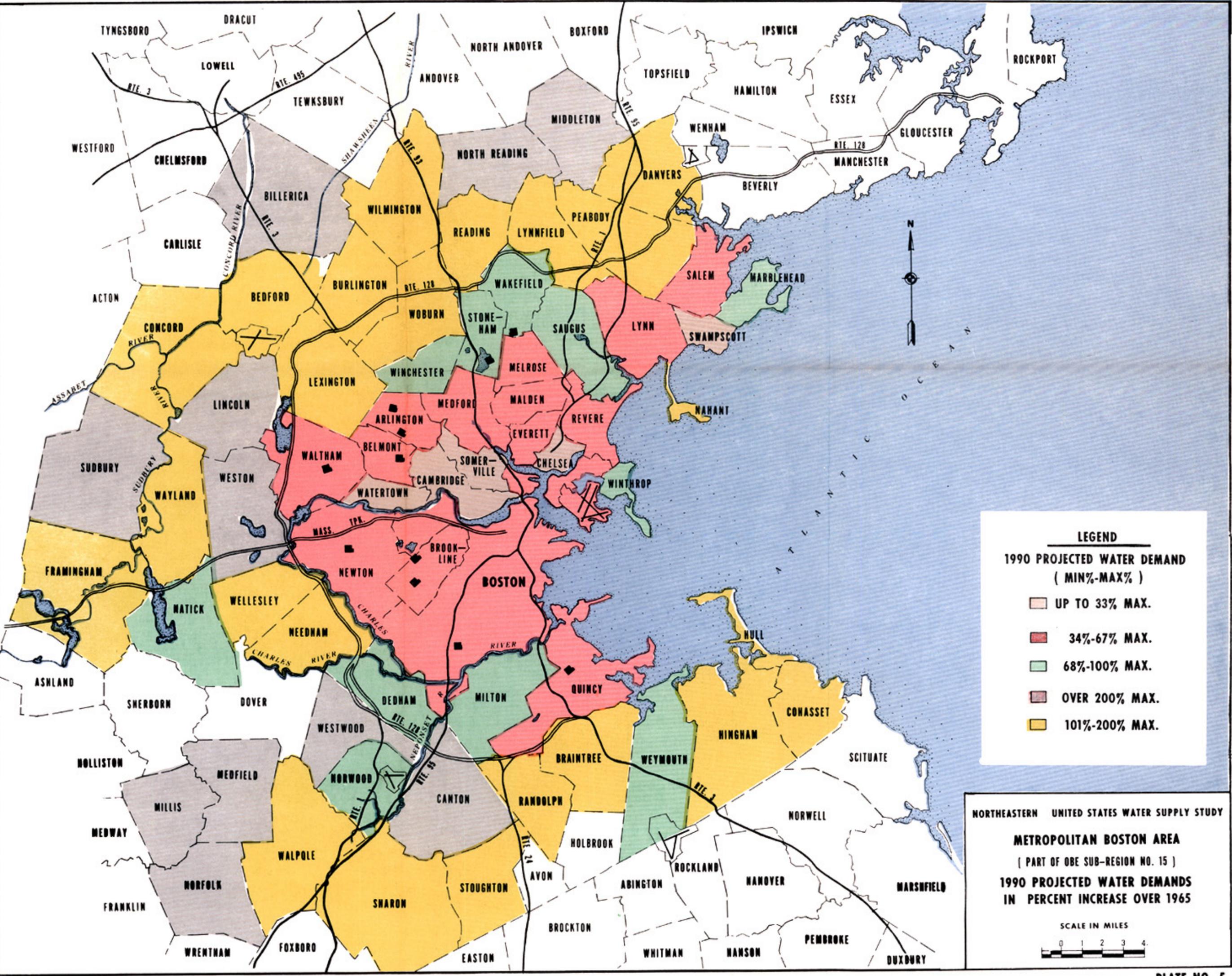
- NOW SERVED
- WITHIN 10 MILE RADIUS
- WITHIN 15 MILE RADIUS

NORTHEASTERN UNITED STATES WATER SUPPLY STUDY

METROPOLITAN BOSTON AREA
 (PART OF OBE SUB-REGION NO. 15)

M.D.C. WATER SUPPLY SERVICE AREA

SCALE IN MILES
 (1 in. = 2.5 Mi. Approx.)



LEGEND

1990 PROJECTED WATER DEMAND
(MIN%-MAX%)

- UP TO 33% MAX.
- 34%-67% MAX.
- 68%-100% MAX.
- OVER 200% MAX.
- 101%-200% MAX.

NORTHEASTERN UNITED STATES WATER SUPPLY STUDY

METROPOLITAN BOSTON AREA
(PART OF OBE SUB-REGION NO. 15)

1990 PROJECTED WATER DEMANDS
IN PERCENT INCREASE OVER 1965

SCALE IN MILES

0 1 2 3 4